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## VOLTAGE CONTROL APPARATUS FOR VEHICLE GENERATOR

### BACKGROUND OF THE INVENTION

5 The present invention relates to a voltage control apparatus for a vehicle generator wherein an ignition switch and a charge lamp are connected in series so that a single input terminal is commonly used for these elements.

10 As a voltage control apparatus for a vehicle generator which has an input terminal for inputting a battery voltage through an ignition switch and a charge lamp and starts the operation when the voltage at the input terminal exceeds a predetermined value, there is known one disclosed in Japanese Patent No. 2707616. Fig. 6 shows a circuit diagram of the voltage control apparatus disclosed in the Japanese Patent.

15 The voltage control apparatus 1 shown in Fig. 6 is arranged in a manner that the voltage control apparatus includes an input terminal L for inputting the voltage of a battery 5 through an ignition switch 3 and a charge lamp 4 connected in series with the ignition lamp and starts the excitation of a rotary  
20 coil 21 of a vehicle generator 2 when the voltage at the input terminal L exceeds a predetermined value. The voltage control apparatus 1 further includes a comparison means 12 which generates an output signal when the voltage at the input terminal L exceeds another predetermined value lower than the  
25 aforesaid predetermined value, and a switch means 14 which

operates in response to the output signal thereby to connect a leak compensation resistor 143 between the input terminal L and the ground.

To be more concrete, the voltage control apparatus 1 shown in Fig. 6 includes comparators 12, 13. The voltage of the input terminal L is applied to each of the negative "-" terminals of these comparators. Constant voltages V1, V2 are applied to the positive "+" terminals of the comparators 12, 13, respectively, wherein  $V1 < V2$ . A transistor 16 is connected to the output terminal of the comparator 12. A transistor 14 serving as a switch means is turned on in response to the output of the transistor 16 applied through a resistor 142. A transistor 1112 is connected to the output terminal of the comparator 13. A power transistor 11 is turned on in response to the output of the transistor 1112 applied through a resistor 1114.

The transistor 14 and a transistor 152 are connected to a comparator 15 through transistors 141, 151, respectively. When the vehicle generator 2 starts the electric power generation operation, the voltage generated by the generator exceeds a constant voltage V3, so that the comparator 15 turns off the transistors 14, 152. In the figure, reference numerals 22, 23 depict the stator coil and the full-wave rectifier of the vehicle generator 2 respectively. A resistor 144 provided between the input terminal L and the ground serves to lower

the voltage at the input terminal L to the ground level upon the normal opening operation of the ignition switch 3.

During the electric power generation operation, the power transistor 11 is turned on and off in response to a transistor 1111. A zener diode 1113 is provided on the base side of the transistor 1111.

An example of the conventional voltage control apparatus for a vehicle generator is shown in Fig. 7 in which a light emitting element such as a light emitting diode driven with a low dissipation power is employed as the charge lamp. When the light emitting diode etc. is employed as the charge lamp as shown in Fig. 7, it is required to mount a current limit resistor in series with the light emitting diode etc. on a vehicle side in order to prevent the occurrence of such a phenomenon that a transistor 152 for turning on the light emitting diode etc. is broken by an overcurrent.

However, when the current limit resistor is mounted on the vehicle side, the arrangement of the apparatus on the vehicle side becomes complicated. Further, even in the case where the current limit resistor is inserted on the vehicle side, there arises a problem that, when a high voltage such as a battery voltage etc. is directly applied to the input terminal L due to the abnormality of the vehicle wiring etc., the transistor for driving the light emitting element (light emitting diode etc.) driven with a low dissipation power may be broken by an

overcurrent.

Further, there is a problem that a dedicated element such as a transistor etc. for lightening the light emitting element is required and that the light emitting element may always be  
5 kept in a lightened state by a current flowing into the input terminal L for starting the operation of the voltage control apparatus.

#### SUMMARY OF THE INVENTION

10 Accordingly, the present invention has been made in order to obviate the aforesaid problems of the prior art, and an object of the present invention is to provide a voltage control apparatus for a vehicle generator having a stable starting circuit which can start the voltage control circuit without  
15 breaking the voltage control apparatus even in an abnormal case that a high voltage is directly applied to the input terminal L of the voltage control apparatus.

Further, another object of the invention is to provide a voltage control apparatus for a vehicle generator which  
20 eliminates a dedicated element such as a transistor etc. which has been employed merely to turning on and off the light emitting element and can turn on and off the light emitting element with a simple circuit arrangement.

Furthermore, still another object of the invention is to  
25 provide a voltage control apparatus for a vehicle generator

which can prevent the occurrence of such a phenomenon that the light emitting element is always kept in a lightened state by a current for starting the operation of the voltage control apparatus which flows into the voltage control apparatus from  
5 the input terminal L through the light emitting element.

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The invention according to aspect 1 is characterized in that in a voltage control apparatus for a vehicle generator which has an input terminal for inputting the voltage of a battery through an ignition switch and a light emitting element  
10 connected in series with the ignition switch and driven by a low dissipation power and which starts the excitation of the rotor coil of the vehicle generator when the voltage at the input terminal exceeds a predetermined value, wherein a resistor for limiting the current flowing through the light  
15 emitting element is disposed between an element within the voltage control apparatus for driving the light emitting element and the input terminal.

The invention according to aspect 2 is characterized in that in a voltage control apparatus for a vehicle generator  
20 which has an input terminal for inputting a voltage of a battery through an ignition switch and a light emitting element connected in series with the ignition switch and driven by a low dissipation power and which starts excitation of a rotor coil of the vehicle generator when a voltage at the input  
25 terminal exceeds a predetermined value, wherein the light

emitting element is lightened by a current itself which is inputted into the input terminal for starting the operation of the voltage control apparatus.

5 The invention according to aspect 3 is characterized, in the voltage control apparatus for a vehicle generator according to aspect 2, in that the light emitting element is coupled through the ignition switch to the base terminal of an NPN transistor for starting the operation of the voltage control apparatus so that the light emitting element is turned on by  
10 a current flowing into the base terminal.

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15 The invention according to aspect 4 is characterized in that in a voltage control apparatus for a vehicle generator which has an input terminal for inputting a voltage of a battery through an ignition switch and a light emitting element connected in series with the ignition switch and driven by a low dissipation power and which starts excitation of a rotor coil of the vehicle generator when a voltage at the input terminal exceeds a predetermined value, wherein a circuit for  
20 detecting the voltage of the input terminal and starting the voltage control apparatus is arranged to be shutdown or inoperable after the vehicle generator starts the electric power generation operation.

25 The invention according to aspect 5 is characterized, in the voltage control apparatus for a vehicle generator according to aspect 4, in that after the circuit for detecting the voltage

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of the input terminal and starting the voltage control apparatus is shutdown after the vehicle generator starts electric power generation operation, the operation of a starting circuit for the voltage control apparatus is maintained by the output of  
5 one phase of the vehicle generator.

The invention according to aspect 6 is characterized in that in a voltage control apparatus for a vehicle generator which has an input terminal for inputting a voltage of a battery through an ignition switch and a light emitting element  
10 connected in series with the ignition switch and driven by a low dissipation power and which starts excitation of a rotor coil of the vehicle generator when a voltage at the input terminal exceeds a predetermined value, wherein a circuit for detecting the voltage of the input terminal and starting the  
15 voltage control apparatus includes a field effect transistor.

The invention according to aspect 7 is characterized in that a light emitting diode is used as the light emitting element.

20 BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a circuit diagram showing a voltage control apparatus for a vehicle generator according to the first embodiment of the invention.

Fig. 2 is a circuit diagram showing a voltage control  
25 apparatus for a vehicle generator according to the first

embodiment of the invention.

Fig. 3 is a circuit diagram showing a voltage control apparatus for a vehicle generator according to the second embodiment of the invention.

5 Fig. 4 is a circuit diagram showing a voltage control apparatus for a vehicle generator according to the third embodiment of the invention.

10 Fig. 5 is a circuit diagram showing a voltage control apparatus for a vehicle generator according to the fourth embodiment of the invention.

Fig. 6 is a circuit diagram showing a conventional voltage control apparatus for a vehicle generator.

15 Fig. 7 is a circuit diagram showing a conventional voltage control apparatus for a vehicle generator.

#### DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

(First embodiment)

20 Fig. 1 is a circuit diagram showing a voltage control apparatus for a vehicle generator according to the first embodiment of the invention. The voltage control apparatus 1 shown in Fig. 1 has an input terminal L for inputting the voltage of a battery 5 through an ignition switch 3 and a light emitting element (light emitting diode 4) driven by a low dissipation power which is connected in series with the ignition switch.

25 The voltage control apparatus is arranged to start the



excitation of the rotor coil 201 of a vehicle generator 2 when the voltage of the input terminal L exceeds a predetermined value.

5 The voltage control apparatus 1 includes a current limit resistor 115 connected in series with a transistor 114 between the input terminal L and the collector of the transistor 114 for lightening the light emitting diode 4.

10 The voltage control apparatus 1 further includes a comparator 108 having a negative "-" terminal to which the voltage of the input terminal L is applied and a positive "+" terminal to which a constant voltage  $V_y$  is inputted.

15 When the ignition switch 3 is closed, the battery voltage is applied to the negative terminal of the comparator 108 through the light emitting diode 4 thereby to change the output of the comparator 108 from a high level to a low level, so that a transistor 110 is turned on. When the transistor 110 is turned on, the voltage control apparatus 1 is started. Thus, a transistor 101 is supplied with a base current through a resistor 104 and hence a rotor coil 201 is supplied with a field current, whereby the vehicle generator 2 is placed in a state of capable of generating electric power.

20 When the vehicle generator 2 is in a state of before starting an electric power generation operation, a comparator 109 is supplied at its positive "+" terminal with zero voltage, so that the comparator 109 outputs a low level thereby to turn

off a transistor 103. Thus, the transistor 114 for driving the light emitting diode 4 is supplied with a base current through a resistor 116 and turned on, whereby the light emitting diode 4 is turned on by the current flowing through the resistor 115.

5 In this case, since the voltage of the input terminal L of the voltage control apparatus 1 is kept at almost same voltage as that of the battery 5 by the resistor 115, the negative terminal of the comparator 108 is kept to be supplied with a voltage higher than the voltage  $V_y$ , so that both the transistors  
10 101 and 114 are surely kept to be supplied with the base current.

Further, even when the input terminal L is directly applied with the voltage of the battery 5 due to the abnormality of the wiring of the input terminal L, the short-circuit of the light emitting diode 4 etc. of the voltage control apparatus  
15 1, since the current flowing into the collector of the transistor 114 is limited by the resistor 115, the transistor 114 is prevented from being broken.

When the vehicle generator 2 starts the electric power generation operation, since both a diode 111 and a capacitor  
20 112 receive the output voltage of one phase of the generator, the voltage of the positive terminal of the comparator 109 becomes larger than the voltage  $V_x$  of the negative terminal thereof. Thus, since the output of the comparator 109 is changed from a low level to a high level, the transistor 113  
25 is tuned on and so the transistor 114 is turned off thereby

to turn off the light emitting diode 4.

Since a transistor 103 and the transistor 101 are switched in response to a predetermined voltage which is obtained by dividing the output voltage of the vehicle generator 2 by resistors 106, 107 and a zener diode 105, the current flowing through the rotor coil 201 is intermittently controlled and so controlled to a predetermined value.

When the current limit resistor 115 is disposed in a manner as shown in Fig. 2, the same technical effect as the arrangement of Fig. 1 can be attained.

As described above, according to the voltage control apparatus for a vehicle generator of the first embodiment, in a case where the light emitting element such as the light emitting diode driven by a low dissipation power is employed as the charge lamp, the resistor for limiting the current flowing through the light emitting element is disposed between the input terminal and the element for driving the light emitting element within the voltage control apparatus. Thus, the voltage control circuit is prevented from being broken even in an abnormal case that the output voltage of the battery is directly applied to the input terminal, and the stable starting circuit for the voltage control circuit can be arranged with the simple configuration.

(Second embodiment)

The second embodiment is arranged in a manner that in the



transistor 122.

When the vehicle generator 2 starts the electric power generation operation, like the first embodiment, since the output of a comparator 109 is changed from a low level to a high level, a transistor 121 is tuned on, so that a transistor 123 is also turned on. Thus, since the battery voltage is applied to the collector terminal of the transistor 123, the current having been supplied to the light emitting diode 4 is cut off, whereby the light emitting diode 4 is turned off.

Further, since the transistor 122 is supplied with the base current due to the turning-on of the transistor 123, the circuit for supplying the base current for the transistor 101 is prevented from being shut down or inoperable.

Since the voltage control operation of the voltage control apparatus of this embodiment is same as that of the first embodiment, the explanation of the voltage control operation of the voltage control apparatus of this embodiment will be omitted.

As described above, according to the voltage control apparatus for a vehicle generator of the second embodiment, the element such as a dedicated transistor etc. which has been employed merely to turning on and off the light emitting element driven with a low dissipation power can be eliminated and the light emitting element can be turned on and off with the simple circuit arrangement.

(Third embodiment)

The third embodiment is arranged in a manner that in the voltage control apparatus for a vehicle generator which has an input terminal L for inputting the voltage of a battery through an ignition switch and a light emitting element (light emitting diode etc.) connected in series with the ignition switch and driven by a low dissipation power and which starts its operation when the voltage at the input terminal exceeds a predetermined value, the circuit for detecting the voltage of the input terminal L and starting the voltage control apparatus is arranged to be shutdown or inoperable after the vehicle generator starts the electric power generation operation.

Fig. 4 is a circuit diagram showing the voltage control apparatus for a vehicle generator according to the third embodiment.

In Fig. 4, when an ignition switch 3 is closed, a transistor 144 is supplied at its emitter terminal with a voltage through a light emitting diode 4 serving as a charge lamp and a current limit resistor 115. In this case, since a transistor 133 is applied at its base terminal with the battery voltage through a resistor 148, the transistor 133 is in a conductive state. Thus, since the transistor 144 is also made conductive, a transistor 122 is supplied with a base current through a resistor 146, so that a transistor 110 is turned on. In

accordance with the turning-on of the transistor 110, a transistor 101 is supplied with a base current through a resistor 104 and so turned on. As a result, a rotor coil 201 is supplied with a field current, whereby the vehicle generator 2 is placed in a state of capable of generating electric power.

In this case, the light emitting diode 4 is lightened by the base current of the transistor 122 flowing through the resistor 146 and the collector current of the transistor 133 flowing through a resistor 147.

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When the vehicle generator 2 starts the electric power generation operation, like the first embodiment, since the output of a comparator 109 is changed from a low level to a high level, a transistor 132 is tuned on, so that a transistor 133 is turned off. Thus, since the transistor 144 is also turned off, the current having been supplied to the base electrode of the transistor 122 is cut off, whereby the light emitting diode 4 is turned off.

20 Further, when the transistor 122 is turned off, the transistor 110 is also turned off, whereby the circuit for supplying the base current for the transistor 101 is shut down or made inoperable. Thus, after the vehicle generator 2 starts the electric power generation operation, a transistor 131 is turned on by the output of the comparator 109 thereby to turn on the transistor 110, whereby the circuit for supplying the base current for the transistor 101 is kept to be operable to

maintain the supply of the base current.

Since the voltage control operation of the voltage control apparatus of this embodiment is same as that of the first embodiment, the explanation of the voltage control operation of the voltage control apparatus of this embodiment will be omitted.

As described above, according to the voltage control apparatus for a vehicle generator of the third embodiment, the circuit for detecting the voltage of the input terminal L and starting the voltage control apparatus is arranged to be shutdown or inoperable after the vehicle generator starts the electric power generation operation. Thus, this embodiment can prevent the occurrence of such a phenomenon that the light emitting element is kept in a lightened state by the current for starting the operation of the voltage control apparatus which flows into the voltage control apparatus from the input terminal L through the light emitting element driven with a low dissipation power.

(Fourth embodiment)

The fourth embodiment is arranged in a manner that in the voltage control apparatus for a vehicle generator which has an input terminal L for inputting the voltage of a battery through an ignition switch and a light emitting element (light emitting diode etc.) connected in series with the ignition switch and driven by a low dissipation power and which starts



its operation when the voltage at the input terminal L exceeds a predetermined value, the circuit for detecting the voltage of the input terminal L and starting the voltage control apparatus includes a field effect transistor.

5        Fig. 5 is a circuit diagram showing the voltage control apparatus for a vehicle generator according to the fourth embodiment.

10        In Fig. 5, when an ignition switch 3 is closed, a field effect transistor (FET) 151 is supplied with a voltage through a light emitting diode 4 serving as a charge lamp and a resistor 152. A transistor 110 is also turned on the moment the FET 151 is turned on, and so transistors 101 and 114 are supplied with base currents through resistors 104 and 116, respectively. Thus, since the transistor 101 is turned on, a rotor coil 201 is supplied with a field current, so that a vehicle generator 2 is placed in a state of capable of generating electric power. Further, since the transistor 114 is also turned on, the light emitting diode 4 is lightened.

20        When the vehicle generator 2 starts the electric power generation operation, like the first embodiment, since the output of a comparator 109 is changed from a low level to a high level, a transistor 113 is turned on, so that the transistor 114 is turned off. Thus, since the current having been supplied to the light emitting diode 4 is cut off, the light emitting diode 4 is turned off.



terminal and the element for driving the light emitting element within the voltage control apparatus.

Thus, the voltage control circuit is prevented from being broken even in an abnormal case that the output voltage of the battery etc. is directly applied to the input terminal, and the stable starting circuit for the voltage control circuit can be arranged with the simple configuration.

According to the invention in aspects 2, 3 and 7, the light emitting element (light emitting diode etc.) driven with a low dissipation power is lightened by a current itself which is inputted into the input terminal for starting the operation of the voltage control apparatus. Thus, a dedicated transistor etc. which has been employed merely to turning on and off the light emitting element can be eliminated and the light emitting element can be turned on and off with the simple circuit arrangement.

According to the invention in aspects 4, 5 and 7, the circuit for detecting the voltage of the input terminal and starting the voltage control apparatus is arranged to be shutdown or inoperable after the vehicle generator starts the electric power generation operation. Thus, the light emitting element can be prevented from being kept in a lightened state by the current for starting the operation of the voltage control apparatus which flows into the voltage control apparatus from the input terminal L through the light emitting element (light

emitting diode etc.).

According to the invention in aspects 6 and 7, the circuit for detecting the voltage of the input terminal and starting the voltage control apparatus includes the field effect transistor. Thus, there is no current for starting the operation of the voltage control apparatus which flows into the voltage control apparatus from the input terminal L through the light emitting element(light emitting diode etc.). Accordingly, the light emitting element is prevented from being kept in a lightened state by the current flowing into the voltage control apparatus from the input terminal.